MOBILE EXPERTS

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Rural Coverage:

The Forgotten Opportunity

Background

During the early 2G deployment in 1991-1994, mobile operators focused on coverage. Capacity was something to plan in the future, but the 2G networks really were focused on "dropped calls" and coverage issues. The widespread deployment of towers in rural areas was unprecedented, and while the investment in rural towers continued for 2G and 3G through about 2005, we have not seen a similar surge of rural investment since then. Why not?

This report will examine the rationale for mobile operators to ignore the rural coverage of their networks, as well as the coverage of third-world networks. We focus on the potential revenue density and cost of deployment in the Western United States and Africa as two key case studies.

Figure 1: Verizon's promised coverage

Source: Verizon

Revenue Density

Clearly, the decision to skip investments in the rural network has been made because investing in the urban network is more lucrative. This can take several forms.

In the United States, locations where population density is lower than 10 people per square kilometer (25 per square mile) translate into a difficult ROI for an operator. That's a large proportion of the country. Note that almost all of the statistical data available on population density list the density by county, but in fact this method understates the area that has low population. For example, mountainous areas in California have populated towns (easily covered by a single mobile site), surrounded by several miles of mountainous terrain with no residents.

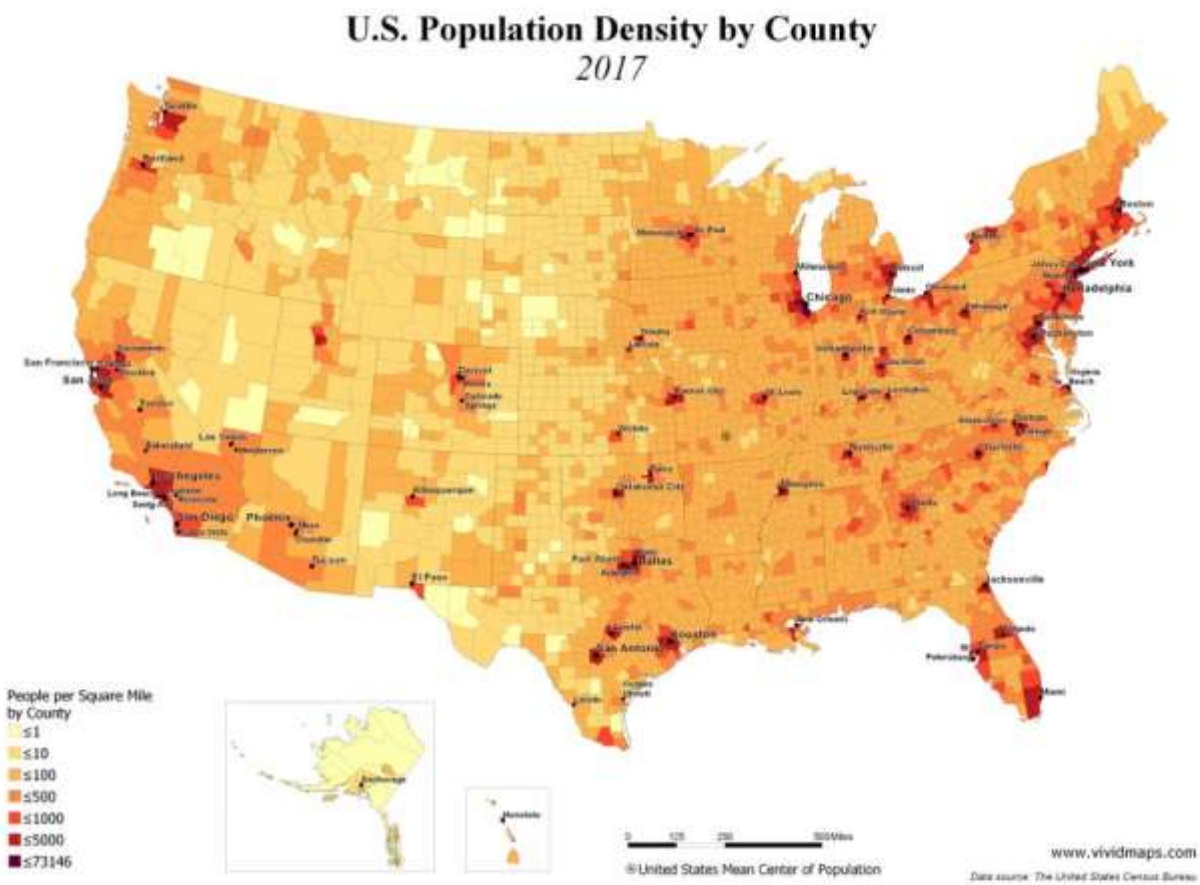

Figure 2: US Population Density by county

Source: Vividmaps

Mobile operators care about population density in terms of the number of customers they can serve, but they also consider "revenue density" in terms of the ROI for rural infrastructure investments. In a rural American county, if we have 10 people per square kilometer, at an average revenue per user of $36[1] results in revenue potential of $4,320 per square kilometer per year.

Developing Nations—Comparing Revenue Density

Our American example of $360 per square kilometer per year is based on low population density and relatively high ARPU. In many developing countries, the operators choose not to invest in coverage with much higher population density. For example, in Kamuli, Uganda, (three hours' drive from the capital city of Kampala) the population density in town comes to roughly 200 people per square kilometer. ARPU in Uganda comes in at roughly $4 per month, so we have revenue density of $9,600/km²/yr in the town. All three mobile operators have some level of coverage in town because the ROI for a simple tower-based macro base station is acceptable.

However, outside of the town of Kamuli the population density drops to about 30 people, and ARPU is likely to be somewhat lower as well. On a recent trip to a school and farm near Kamuli, we interviewed local residents and we estimate that ARPU could be roughly $3 per month. The revenue density: $1,080/km²/yr.

Location	Population Density (residents/km²)	ARPU ($/mo)	Revenue Density ($/km²/yr)	Coverage Today
San Francisco, CA	50,000	$45	$27M	LTE-A, 3G, 2G, multiple bands
Caliente, Nevada	9	$30	$3,240	None
Strawberry, California	10	$30	$3,600	Limited LTE coverage
Kamuli-town, Uganda	200	$4	$9,600	2G, some 3G
5 km outside Kamuli, Uganda	30	$3 (potential ARPU)	$1,080	None

Figure 3: Revenue Density Comparison by Location

Source: Mobile Experts

[1] Mobile Experts esimates that rural ARPU is lower than urban ARPU. We have no primary research to quantify this, so we are simply estimating a 25% lower ARPU in rural America.

Cost factors

The cost of the base station equipment matters. Revenue potential of $1,000 per year could be addressable, if the infrastructure was cheap enough. In both rural American and rural African cases, the backhaul infrastructure is simply non-existent, so fiber and wireless backhaul (or satellite backhaul) will be necessary to create a backbone. In this way, delivering each GB of mobile data is much more expensive in rural areas than in busy urban areas.

	USA GSM	USA LTE	UGANDA GSM	UGANDA LTE	COMMENT
CAPEX					
Spectrum	$ -	$ -	$ -		Assume spectrum is free--already licensed for cities. Uganda LTE only at 2600 MHz
Base Station Equipment	$5,000	$15,000	$3,000	$12,000	price in developing country with Chinese competition
Site Acquisition/Setup	$50,000	$50,000	$20,000	$20,000	regulations in USA. Assume low regulation in Uganda but concerns about security and power
Backhaul Equipment	$10,000	$20,000	$10,000	$20,000	USA and Uganda: Assume wireless backhaul if <200 miles from major city, satellite beyond.
Core Network Capacity	$902	$2,460	$902	$2,460	Amortized cost of core network according to capacity used
OPEX					
RF Planning	$5,000	$5,000	$5,000	$5,000	Assuming RF planning for large scale deployment done altogether.
Installation for RF site equipment	$25,000	$25,000	$10,000	$10,000	Assume tower based installation
Installation for backhaul	$5,000	$5,000	$5,000	$5,000	Assume wireless backhaul for the average case
Site Rental	$0	$0	$0	$0	Assume owned sites
Energy	$544	$1,088	$544	$1,088	Annual cost at $0.12 per kWh. Assume GSM uses roughly half the power of LTE base station
Backhaul operation	$100	$100	$60	$60	Assume wireless backhaul to owned fiber…no routine opex but only maintenance costs
Core Network operation	$1	$600	$1	$600	Annual cost to maintain and operate SGSN, GGSN, core data servers.
Site Maintenance	$6,000	$6,000	$11,000	$11,000	Annual cost for Generators, replace failures, electronic maintenance, antenna adjustment, lightning strikes
Total Cost of Ownership					
Total 8 year cost	$154,062	$184,764	$146,742	$176,444	Including both CAPEX depreciated over 8 years and 8 years of OPEX
Coverage radius (km)	3	2.5	4	3	
Coverage area (km2)	28.26	19.625	50.24	28.26	
TCO per square kilometer	**$5,452**	**$9,415**	**$2,921**	**$6,244**	c

Figure 4: Detailed Cost Analysis for Rural Deployment

Source: Mobile Experts. Note: Assuming flat terrain

Figure 5: Total Cost of Ownership for various rural networks

Source: Mobile Experts. Note: Assuming flat terrain

Terrain

Clearly, the terrain plays into the cost equation as well. The simple cost model inherently assumes good coverage over flat terrain, but in rural areas this assumption is often false. In rugged terrain, establishing additional cell sites for a single stretch of highway can be extremely expensive, with coverage limited to about 0.2 km^2 and absolutely no residential homes within the coverage area. The revenue potential for people in cars—driving through the canyon—is very limited because each customer will only be on the network for 30 seconds before leaving the coverage area. In this way, terrain plays a major role in the economic case for tower siting.

The total cost of covering each square kilometer can rocket up by a factor of 10 with limited coverage in mountainous terrain. Clearly, this changes the calculus for a mobile operator that expects revenue density of roughly $5,000 to $9,000 per year: more than 10 years could be required to achieve payback on the investment.

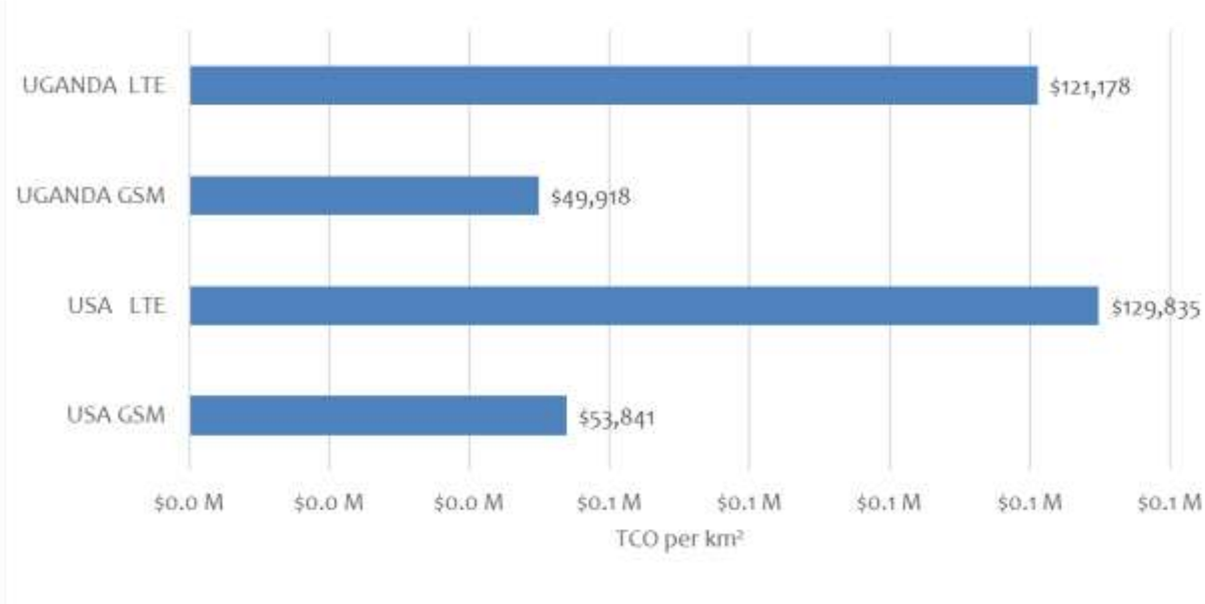

Figure 6: Higher TCO in mountainous terrain

Source: Mobile Experts. Note: Assuming rugged terrain

The Bottom Line: TCO per km^2 and Revenue per km^2

Whether they use a spreadsheet or not, mobile operators make decisions at a very local level based on this simple question: Will they make more money than they spend?

In locations such as San Francisco and Kamuli-town, plenty of revenue is available, and the ROI is quite clear. However, outside of cities the investment is marginal or even worse.

Location	Terrain	TCO/ km^2	Revenue/ km^2	Payback time
Outside of Kamuli Uganda	Flat	$2,016	$1,080	2 years
Caliente, NV	Hilly	$30,000	$3,240	2.7 years
Strawberry, CA	Mountainous	$130,000	$3,600	36 years

Based on this very simple ROI calculation, we can easily understand why the American operators focus almost all of their investment in urban areas. In the USA, most flat areas with a major highway have rudimentary coverage, but mountainous areas can lack coverage. It's simple: there's not enough traffic to justify the investment.

In developing markets like Uganda, our calculations indicate that investment in additional macro sites will pay off within two years. Despite the low ARPU. The difficulties in these poor countries are not technical in nature; investors are often wary of government corruption or theft of their equipment, so progress in network development has been slow.

Closing Thoughts

The 2G buildout in the 1990s was popular because it established wide coverage for a useful service. Everyone, in all areas, wanted the same services. Today, in rural markets the local people know that LTE is possible, and that 5G is coming. But in our survey they almost unanimously said that they desperately want 2G features (voice and text), and if necessary they can drive to town for the Internet. Of course they would also love to have LTE or 5G coverage with strong broadband service as well.

2G base stations can be built much cheaper than LTE base stations, and looking at the raw cost of radio hardware we would estimate that GSM can be roughly 35% of the cost of an LTE base station. However, the backhaul cost will dominate in this case. If fiber is deployed for backhaul, then deploying an LTE network for rural coverage is much more sensible than a GSM network. The ARPU could be double, and the TCO could be fairly similar in the overall view. On the other hand, if satellite backhaul is used, then the GSM option may be preferable to avoid expensive variable costs for backhaul bandwidth.

In the end, we expect ongoing slow progress in developing markets but we don’t expect to see much direct investment in rich rural markets. There’s an opportunity here for cheaper low-bandwidth solutions based on satellite backhaul for simple text or voice apps.